2.0 PROJECT HISTORY

CTI currently produces primary, tertiary and quaternary amines at its plant in Corsicana, Texas. These amines are used in a variety of industrial applications, including, mining, road building, lubrication, petroleum exploration, and fuel additives. The production process results in the generation of industrial non-hazardous wastes, including ammonia waste waters containing salts, polysulfides, amines and alcohols. Before acquisition of the plant by CTI, Jetco owned and operated the plant, manufactured products similar to those currently produced by CTI, and generated similar industrial wastes. Jetco disposed of these wastes in Class I injection well WDW-117, which was perforated over the lower two sandstone units of the Woodbine Formation, from 1974 to 1994. The permitted injection rate for WDW-117 was 150 gallons per minute (gpm), and the well was successfully operated until injection ceased in 1994. This well is now plugged and abandoned.

CTI applied to the Texas Commission on Environmental Quality (TCEQ) on July 20, 2001 for a new permit to construct and operate an underground injection well for the disposal of the industrial, nonhazardous wastes generated at the Corsicana facility. A permit to install the injection well was granted on 3 September 2004. The permit restricted injection to the lower sandstone unit in the Woodbine Formation, based on TCEQ's interpretation of a geophysical log from well WDW-117 that the TDS concentration in the lower sandstone unit was approximately 17,981 ppm. The permit included a requirement (Provision V.G.3) that a groundwater sample be collected and analyzed from the proposed injection zone for TDS and ammonia as nitrogen. The CTI injection well (WDW-394) was drilled in May 2005. The location of WDW-394 is shown on Figure 2-1.

Groundwater samples were initially collected from the proposed injection zone on 30 May 2005. The laboratory results of the May 2005 sampling event indicated a TDS concentration of 6,200 ppm and an ammonia as nitrogen concentration of 8.9 ppm. A report documenting the May 2005 sampling event was submitted to the TCEQ on 29 August 2005. This report included a conclusion that the analytical results may not be representative of actual aquifer conditions due to sample preservation methods, holding time and/or analytical procedures. This conclusion was based on field measurements of specific gravity and geophysical borehole data, which would indicate that the TDS concentrations should have been greater than the laboratory reported levels. The report theorized that the sampling preservation techniques utilized may have allowed the samples to degas and the dissolved solids to precipitate from the samples prior to analysis. As a result of these concerns, a second sampling event was conducted on 7 February 2006.

During the February 2006 sampling event, 10 samples were collected for TDS analysis. In an effort to minimize any alteration of the chemistry of the groundwater after it was removed from the formation, the TDS analyses were conducted on site by an independent laboratory immediately after sampling. The resulting average TDS concentration was 8,579 ppm. Two of the ten samples were retained for analyses of volatile organics compounds, semi-volatile organic compounds, RCRA metals, ammonia as nitrogen, and dissolved gases. These two samples were preserved, as appropriate, and shipped off site to an independent laboratory for analysis. The two analytical results for ammonia as nitrogen yielded an average concentration of 5.12 ppm. Results of the other detected constituents are discussed in Section 5.2.2.

WDW-394 is located approximately 1,268 feet southwest of the former location of WDW–117. The WDW-394 location was intended to be outside the radius of the plume from WDW-117. However, ammonia as nitrogen was detected in the groundwater samples collected from WDW-394, indicating that WDW-394 is located within the plume of the former WDW-117. As presented in Section 4, revised modeling that includes additional data collected from WDW-394 also indicates that WDW-394 is within the plume of WDW-117.

3.0 REGULATORY JUSTIFICATION

TCEQ regulations which address exemption of an aquifer from designation as a potential USDW are found at 30 TAC §331.13, and the analogous federal regulations are found at CFR 40 § 146.4. EPA has also developed a guidance document (*GWPB Guidance #34*) that was prepared for the purpose of providing "guidance to EPA Regional offices on the revised process for the approval of State primacy applications and the process for approving modifications in delegated programs, including aquifer exemptions." Based on the discussion of "Substantial" versus "Non-substantial" Revisions in GWPB #34 and the fact that the TDS concentration of the Woodbine aquifer in the area of requested aquifer exemption is greater that 3,000 parts per million, the requested revision to the Texas' UIC program would be considered "Non-substantial" and the authority for approval would be delegated to the Regional Administrator.

Since Texas has been delegated the federal authority for implementation of the UIC program, the designation of an exempt aquifer in Texas must comply with state regulations. In order for the TCEQ to approve a petition for an aquifer exemption, the applicant must demonstrate that site specific conditions comply with 30 TAC 331.13(c), which states:

An aquifer or portion of an aquifer may be designated as an exempted aquifer if the following criteria are met:

> *(1) It does not currently serve as a source of drinking water for human consumption; and*
>
> *(2) Until exempt status is removed according to procedures in subsection (f) of this section, it will not in the future serve as a source of drinking water for human consumption because:*
>
> > *(A) It is mineral, hydrocarbon or geothermal energy bearing with production capability;*
> >
> > *(B) It is situated at a depth or location which makes recovery of water for drinking water purposes economically or technologically impractical;*
> >
> > *(C) It is so contaminated that it would be economically or technologically impractical to render that water fit for human consumption; or,*
> >
> > *(D) It is located above a Class III well mining area subject to subsidence or catastrophic collapse.*

Designation of an exempted aquifer must be submitted to EPA as part of a UIC Program and is not final until approved by the EPA as part of the delegated UIC program.

4.0 RESERVOIR MODELING

This section discusses the plume modeling performed in support of the aquifer exemption request for WDW-394 and summarizes the pertinent characteristics of the injection reservoir and the confining zone. The Sandia Waste Isolation Flow and Transport Model (SWIFT) was used to simulate the geometry of the waste plume for the proposed aquifer exemption. The injection reservoir is defined as that part of the injection zone through which injected waste water and displaced reservoir fluids will flow and pressure will increase. For the CTI well, the lower Woodbine Formation comprises both the permitted injection zone and the injection reservoir. An aquifer exemption is requested for the TCEQ permitted injection zone that comprises the lower Woodbine interval from 2,920 to 3,000 feet below Kelly bushing and extends for a radius of 4,000 feet from the approximate center of the modeled plume extent of previously conducted and planned waste water injection activities at the property that now comprises the CTI facility. The requested injection interval is from 2,955 to 3,000 feet BKB. WDW-394 has been constructed to Class I injection well standards as required by the State of Texas.

As noted in Section 2.0, Jetco operated Class I non-hazardous injection well WDW-117 on the property from 1974 to 1994, before acquisition of the plant by CTI, at a permitted injection rate of 150 gallons per minute (gpm). WDW-117 was plugged and abandoned, and WDW-394 was installed in 2005 at a location 1,268 feet from the former WDW-117. Drilling information from the installation of WDW-394 as well as historical operation records and data from WDW-117 provide adequate information to characterize the future reservoir behavior.

Many of the depths in the text that follow will be referenced to below Kelly bushing (BKB). For reference, the ground level elevation at WDW-394 is 387 feet above sea level, and the Kelly bushing (KB) elevation was 14 feet above ground level (401 feet above sea level). The KB elevation of WDW-117 was 7 feet above ground level and 397 feet above sea level.

4.1 SUMMARY OF THE STRATIGRAPHY AND LITHOLOGY OF THE CONFINING INTERVAL AND INJECTION INTERVAL FOR THE EXEMPT AQUIFER

Detailed geologic information can be found in Section V, Geology, of the WDW-394 permit application (Cook-Joyce, 2004). Cross sections of the geology underlying the CTI facility and structure contour and thickness maps of the injection zone are also given in the Geology portion of the permit application. Summary information is provided below.

The CTI facility is located west of the Mildred-Powell Graben that is the extreme western part of the Mexia-Talco Fault system. The Mildred fault is located on the very eastern edge of the 2.5 mile Area of Review. This fault has approximately 300 to 400 feet of throw at the depth of the injection reservoir. The fault extends deep into basement rocks and has a surface expression. The Mildred fault is not vertically transmissive as evidenced by the fact that the fault forms a seal and sets up the Mildred oil field. The range of well depths in the Mildred field is 740-1,250 feet in the Nacatoch Sand (Hudnall, 1951).

The injection reservoir is designated as the Lower Woodbine Sand of the Woodbine Formation. The Woodbine Formation consists of alternating layers of sand and shale that are loosely grouped into an upper and lower part that are separated by correlative shale units. The injection zone for the portion of the aquifer proposed for exemption is overlain by approximately 2,800 feet of strata that will serve to isolate it from overlying potable water aquifers.

4.1.1 Description of the Confining Zone

A geologic investigation (Cook-Joyce, 2004; Section V) conducted over an expanded area determined that the Lower Woodbine sand injection reservoir is correlative over a large area within and beyond the Area of Review (AOR). The lower Woodbine comprises both the confining zone and the injection zone. The top of the confining zone/injection zone was logged at 2,920 feet BKB in WDW-394. The confining zone consists of a massive shale approximately 35 feet thick that is laterally continuous and correlative across the AOR. This shale will serve to contain the waste and prevent it from leaving the injection zone.

The top of the Upper Woodbine was logged at an approximate depth of 2,550 feet BKB in WDW-394 and extends to a depth of approximately 2,869 feet BKB. The Eagle Ford Formation overlies and confines the Upper Woodbine. The Eagle Ford is found between the approximate depths of 2,130 to 2,550 feet BKB and consists of massive shale. The Austin Chalk is located above the Eagle Ford Shale. It consists of limestone interbedded with thin sands and shales. The Taylor Group conformably overlies the Austin Chalk and is composed of shale and marl.

Overlying the Taylor is the Navarro Group of shale, thin sands and marl. The Navarro Group is exposed at the surface at the CTI site.

There are only three existing wells within the 2.5-mile AOR that penetrate the upper Woodbine. These wells do not penetrate the area of the lower Woodbine that is proposed for exemption, and do not present an opportunity for injected fluids to leave the injection zone as discussed in Section VIII (Area of Review) of the WDW-394 Permit Application (Cook-Joyce, 2004). There are no industrial, saltwater, water flood or municipal disposal wells that inject into the Woodbine Formation within the CTI AOR. Regional oil and gas production outside the AOR is from strata that are shallower than the CTI injection reservoir (Hudnall, 1951).

4.1.2 Description of the Injection Zone and Injection Reservoir

The lower Woodbine injection zone also consists of alternating layers of sand and shale and extends from 2,920 to 3,000 feet BKB from the WDW-394 logs. The sands consist of friable, iron bearing fine-grained sand and sandstone with shale and sandy shale interbeds. The sand beds are generally thicker in the lower Woodbine. The injection reservoir is equivalent to the injection interval from 2,955 to 3,000 feet BKB and has sufficient permeability and porosity to support injection as evidenced by the successful twenty-year operation of WDW-117. The Lower Woodbine is laterally continuous across the Area of Review (AOR). WDW-394 was perforated in the lower Woodbine from approximately 2,959 to 2,969 feet BKB and from 2,980 to 2,999 feet BKB. These perforations are well below the top of the permitted injection zone and the top of the proposed exempt aquifer at 2,920 feet BKB. This will serve to provide additional confinement for the injected fluid.

4.2 RESERVOIR PROPERTIES

New information was obtained during the drilling of WDW-394. The new and existing information is discussed below and was incorporated in new reservoir models for this Aquifer Exemption Request.

4.2.1 Falloff Test Results

Table 4-1 provides a compilation of falloff test results for the proposed lower Woodbine exempt aquifer. Several falloff tests have been performed on the former WDW-117 and at a Department of Energy sponsored geothermal well drilled at the nearby Navarro College in 1979

(Environmental Aquaculture Services, 1984). No falloff tests have been performed on WDW-394 to date.

After a workover in 1980, a 19-hour pumping test at 100 gpm was performed by Radian Corporation at the Navarro College geothermal well (Environmental Aquaculture Services, 1984). This is the most reliable test available for correlative Woodbine strata close to the Corsicana Technologies plant. This is because accurate data were obtained and the well was in excellent working order in a virtually virgin reservoir. From the test, a permeability of 449 millidarcies (md) was derived.

The falloff tests performed on WDW-117 yielded lower permeability and negative skin values. The negative skin is indicative of improved permeability in the near wellbore region. This is probably a response to near wellbore permeability improvement from periodic acid jobs. The calculated permeability is consistently lower than that derived from the Navarro College well test. This may be due to the fact that the WDW-117 tests were not run long enough to reach radial flow conditions. The 1993 test at WDW-117 was analyzed using modern inverse regression and other modeling techniques. In the 1993 test report (Envirocorp, 1993), it is suggested that radial flow would be reached after 100 hours of falloff. The reported transmissivity was derived by model extrapolation of the falloff curve.

4.2.2 Results of the WDW-394 Whole Core Analysis

Whole core was obtained during the drilling phase of WDW-394. Permeability and porosity tests were run on the core by Omni Laboratories (2005). Table 4-2 presents the results of the core analysis on samples from the perforated interval from approximately 2,959 to 2,969 feet BKB and from 2,980 to 2,999 feet BKB. From these intervals, the average permeability was 191 md and the average porosity was 20.7%. The permeability lies within the range of values derived from the earlier falloff tests as discussed in Section 4.2.1. The core-derived values of permeability and porosity were used in the modeling discussed in Section 4.3 because they represent site-specific hydraulic properties of the reservoir.

4.2.3 Injection Reservoir Thickness, Temperature, and Temperature Gradient

From the WDW-394 log, approximately 36 feet of net sand is in the perforated interval and is available for injection in the lower Woodbine. This value was used in the modeling discussed in Section 4.3.

An initial bottomhole temperature of 141° F at 3,114 feet BKB depth (3,100 feet below ground level) was measured in WDW-394. For an average surface temperature of 74° F, the temperature gradient is 0.021613° F/ft = ((141° F - 74° F)/3,100 feet). This corresponds very well with the published geothermal gradient of 0.02° F/ft (Western Co., date unknown).

Using the geothermal gradient of 0.021613° F/ft with an average surface temperature of 74° F, yields a bottomhole temperature of 137.6° F at 2,955 feet.

4.2.4 Salinity, Density, and Viscosity of the Injection Reservoir Fluid

Samples of the formation fluid from the proposed exempt aquifer were obtained from WDW-394 (Table 4-3). The samples were analyzed for total dissolved solids (DHL Analytical, 2006). The average total dissolved solids (TDS) from 10 samples was 8,579 mg/l. Assuming an equivalent 8,579 ppm NaCl fluid, this corresponds to a density of 61.97 lb/ft^3 at 137.6° F (Numbere et. al, 1977).

The viscosity of the injection reservoir fluid at various temperatures was calculated for an equivalent 8,579 ppm NaCl brine. This was determined using the nomograph provided in Earlougher (1977; Fig D.35) as given in Table 4-4.

4.2.5 Salinity, Density, and Viscosity of the Injectate Fluid

WDW-394 is permitted to inject within a range of fluid densities between freshwater, 0.998 SG at 68° F, and brine of 1.15 SG at 68° F. Assuming an equivalent NaCl fluid, this corresponds to a TDS range of 0.0 ppm to 20.4 percent NaCl at 68° F. The corresponding densities at depth are 61.61 lb/ft^3 at 137.6° F for 0.0 ppm injectate and 70.64 lb/ft^3 at 13.76° F for 20.4 percent NaCl injectate (Numbere et. al, 1977).

The viscosity of the injectate at various temperatures was calculated for an equivalent 0.0 and 204,000 ppm NaCl brine. This was determined using the nomograph provided in Earlougher (1977; Fig D.35) as given in Table 4-4.

4.2.6 Initial Reservoir Pressure and Pressure Gradient

The initial reservoir pressure was 1,007 psig (1,022 psia) at 2,940 feet BKB at WDW-117 (Pumphrey, 1984). The final shut-in pressure measurement on 5/2/94 at the now plugged WDW-117 was 1,126 psia at 2,940 feet BKB. This indicates that the final shut-in pressure was 104 psi above the initial pressure (TDI, 1994). This means that the impact of 20 years of injection in the reservoir was relatively small.

The initial pressure in WDW-394 at the top of the injection reservoir, 2,955 feet BKB, was determined as follows. Selective formation tester logs were run during the completion of WDW-394. The initial pressures were measured by Precision Energy Services (2005) on the dates given in Table 4-5 below. The sand designations refer to individual Woodbine sands that were previously mapped across the AOR. The proposed exempt aquifer is comprised of the Lower Woodbine A sand at a log depth of 2,955 feet to 3,000 feet below Kelly Bushing (BKB). The B, C, and D sands comprise the Upper Woodbine and are stratigraphically higher than the A sand.

From Table 4-5, the variation in pressure with depth is not linear. For example, the pressure in the C sand is higher than that in the underlying B sand. This is an indication that there is hydraulic isolation between the Woodbine sand layers. This means that the 35 foot shale overlying the proposed exempt aquifer provides a hydraulic barrier that will prevent upward migration of injected fluids.

Using the reservoir fluid density derived above, the pressure gradient for the exempt aquifer is 0.430347 psi/ft (61.97 lb/ft^3/ 144 in^2/ft^2). Using this gradient to convert the pressure measurement to the top of the current injection reservoir/exempt aquifer yields a final shut-in pressure of 1,120 psi at 2,955 feet BKB at WDW-394:

$$1120\ psi_{2955\ BKB} = 1132\ psi - [(2982\ ft\ BKB - 2955\ ft\ BKB)(0.430347\ psi/ft)]$$

4.3 RESERVOIR MODELING

A groundwater flow and contaminant transport model was constructed in order to determine the pressure increase and the extent of the waste front from the proposed 30-year operation of CTI's WDW-394. Previous injection from WDW-117 was also included in the model. The Sandia Waste-Isolation Flow and Transport model (SWIFT) was selected as the reservoir model. SWIFT is routinely used to model deep well injection in U.S. Environmental Protection Agency No Migration Petition applications. The vertical extent of waste was calculated using analytic models for advection. The model inputs are summarized in Table 4-6. The injection was modeled for thirty years at a constant rate of 50 gpm. This is the permitted average rate for WDW-394.

4.3.1 Description of the SWIFT Code

SWIFT was originally called SWIP (Survey Waste Injection Program) and was developed for the U.S. Geological Survey (Intercomp, 1976). The model code was designed to model waste injection in deep brine aquifers under conditions of variable fluid density, viscosity, and temperature. The code has been extensively documented (Reeves et al., 1986; Finley and Reeves, 1982; Ward et al., 1987; Reeves and Ward, 1986; Intercomp, 1976).

SWIFT is a three-dimensional finite difference model that can simulate ground water flow, contaminant transport, and heat transport in single or dual porosity media. The equations governing groundwater flow and solute transport are coupled through: 1) the pore fluid velocity; 2) the dependence of the fluid density on pressure, solute mass fraction and temperature; and 3) the dependence of fluid viscosity on solute mass fraction and temperature.

The SWIFT model has been verified and validated in several reports. Ward et al. (1984) benchmarked SWIFT against eleven analytical solutions and field problems. These problems explore a wide range of SWIFT's capabilities including variable density flow and disposal well injection. Illustrative problems using the SWIFT code have been published in two reports (Finley and Reeves, 1982; Reeves et al., 1987).

4.3.2 Description of the SWIFT Model for the Proposed Exempt Aquifer

The injection reservoir for the proposed WDW-394 exempt aquifer was modeled using a finite difference grid consisting of 26,344 nodes (148 in the x and 178 in the y direction) positioned around the well location. The grid spacing varies from 25 feet by 25 feet at the wells to 400 by 400 feet at far edges of the modeled area. The length of the grid is approximately 30,000 feet in the x and 48,000 feet in the y directions.

The model simulates conditions at the top of the Lower Woodbine Formation (top of the proposed injection reservoir) at a depth of 2,955 feet BKB. The model inputs are given in Table 4-6.

No flow boundaries are specified for the top and bottom of the modeled confined aquifer. Carter-Tracey boundary conditions were imposed on all sides of the model area. This allows for the simulation of infinite aquifer conditions. The model assumes homogeneous and isotropic, porous media flow conditions. A constant thickness and dip were imposed on the entire model area. The thickness is based on the electric log response from the perforated interval in WDW-394. The dip was assigned based on the structure of the injection zone and is equivalent to 0.63 degrees to the east.

The base case model does not include injection from WDW-117. Both injection from WDW-117 and WDW-394 are included in a sensitivity run as follows. A portion of the historical flow from WDW-117 was input at the average rate for the period July 7, 1974 until April 4, 1994, when WDW-117 was taken out of service. WDW-117 was perforated over 76 feet of the Upper Woodbine B sand as follows:

2,790 feet – 2,828 feet BKB = 38 feet

2,832 feet – 2,844 feet BKB = 12 feet

2,926 feet – 2,932 feet BKB = 6 feet

2,935 feet – 2,955 feet BKB = 20 feet

In WDW-117, the ground level elevation is 390 feet above sea level (ASL) and the KB elevation is 397 feet ASL. The relationship between the two wells is given below in Table 4-7. In WDW-394 the ground level elevation is 387 feet above sea level (ASL) and the KB elevation is 401 feet ASL.

In the absence of continuous flowmeter survey information, it was assumed that the flow of fluids in the Woodbine sands was evenly distributed in the perforated intervals. Since only 26 feet of the WDW-117 perforations were in the A sand, 26/76 feet = 0.342 or 34.2% of the flow could have entered the lower Woodbine A sand. Therefore 34.2% of the flow from WDW-117 was allocated in the revised SWIFT model. From Table 4.8, the total volume injected in WDW-117 was 368,266,005 gallons over 7204 days for an average rate of 6833.71 ft^3/day. The average rate for WDW-117 was calculated as 34.2 percent or 2337.13 ft^3/day.

Zero flow was modeled for the remaining time period for WDW-117. At the model time corresponding to July 1, 2006, a constant injection rate of 50 gallons per minute (gpm) was specified for the anticipated 30-year duration of the future operation of WDW-394. The actual injection rate will most likely be lower than the permitted rate and will be further reduced by periods of no injection when the well is shut in.

Three separate SWIFT model runs were executed. Run CRSCAN20.DAT used a freshwater injectate density for the entire run and only the flow from WDW-394. Run CRSCAN21.DAT used an injectate specific gravity of 1.15 for the entire model run and only the flow from WDW-394. All other inputs are the same. In addition, another run of CRSCAN21.DAT was performed, called CRSCAN22.DAT, that used 1.15 SG injectate density and includes the flow from WDW-394 and WDW-117.

4.3.3 Definition of the SWIFT Model Lateral Waste Plume Extent

In the figures that accompany this section, the model results are depicted as contours of relative concentration. The relative concentration, C/Co, is the calculated model concentration, C, divided by the initial waste concentration, Co. The full strength waste in the model has a C/Co of 1.0. For example, the C/Co contour 1.0E-02 represents a concentration reduction of a factor of 100 from the initial waste concentration. Therefore, if the initial concentration of any waste constituent is known, the concentration reduction at a particular modeled distance from the well can be determined.

In order to determine the lateral extent of the waste plume, it is necessary to identify the worst case waste stream constituent. Table 4-9 lists the constituents in the CTI waste stream. For CTI, the worst case constituent was determined to be arsenic at a concentration of less than

5.0 mg/l. Arsenic has a primary drinking water standard of 0.010 mg/l. The plume front can be compared to this standard for the determination of waste migration impacts.

For evaluation purposes, the arsenic concentration in the injectate is assumed to be the upper, not-to-be-exceeded value of 5.0 mg/L. In order for this level of arsenic in the waste to be reduced to the primary drinking water standard, a concentration reduction factor of 0.002 (0.010 mg/l/5.0 mg/l) is required. This means that once the outside maximum waste concentration of arsenic is reduced by approximately three orders of magnitude of its initial concentration, it will no longer be above the primary drinking water standard for arsenic.

In order to provide a conservative estimate of the plume extent, a maximum concentration, Co, of arsenic in the waste stream of 5 mg/l was used. A three order-of-magnitude reduction in the initial waste concentration is necessary to reach the primary drinking water standard 0.010 mg/l. The C/Co contour of 0.001, therefore, was used to determine the extent of the waste front.

4.3.4 SWIFT Lateral Plume Modeling Results

The results from run CRSCAN20.DAT (freshwater injectate density) are depicted in Figure 4-1 for 7/1/2036 (end of WDW-394 30 year injection at a constant rate of 50 gpm). The plume diameter is approximately 8,000 feet. The relative concentration contour, C/Co, of 0.001 defines the extent of the plume. At this distance from the approximate center point of the plume, the concentration of arsenic due to the historical and planned injection of wastewater from the CTI property will be attenuated below the primary drinking water standard of 0.010 mg/l due to dispersion and diffusion.

The results from run CRSCAN21.DAT (1.15 specific gravity injectate density) are depicted in Figure 4-2 for 7/1/2036 (end of WDW-394 30-year injection at a constant rate of 50 gpm). The results are virtually identical to the freshwater density run. At this time scale, buoyancy effects due to the density contrast between the injectate and the formation fluid are overwhelmed by the displacement of fluid due to injection. Again, the plume diameter is approximately 8,000 feet. As in the previous run, the relative concentration contour, C/Co, of 0.001 defines the lateral extent of the plume.

Run CRSCAN22.DAT is identical to run CRSCAN21.DAT (high density injectate) except that the injection from WDW-117 is included. The results of historical injection into WDW-117 with